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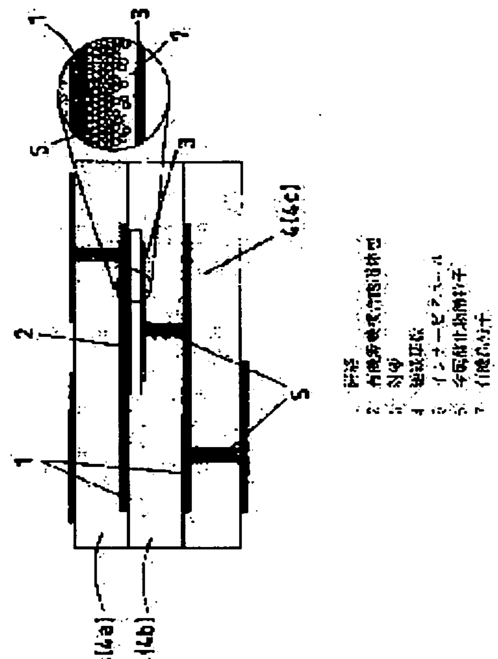
(71)Applicant : MATSUSHITA ELECTRIC IND CO LTD
(72)Inventor : TAKEOKA HIROKI
SAITO TOSHIHARU
SHIODA KOHEI

(54) CAPACITOR BUILT-IN CIRCUIT BOARD AND ITS MANUFACTURING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To achieve a capacitor built-in circuit board that is suited for the manufacturing process of a printed-wiring multilayer board and incorporates a high-capacity capacitor.
SOLUTION: A metal oxide fine particle 6 such as a titanium oxide having a high dielectric constant is formed on the surface of a copper foil 1 of an insulating substrate 4a of a prepreg by electrolytic deposition, and further an organic macromolecule 7 is formed by electrolytic deposition to form an organic/ inorganic compound dielectric layer 2. A counter electrode 3 is formed on the surface of the dielectric layer 2 by copper plating to complete a capacitor, and other insulating substrates 4b and 4c are bonded so that the capacitor can be sandwiched. In the organic/inorganic compound dielectric layer 2, the density of the metal oxide fine particle 6 is large on the surface of the copper foil 1, and is smaller away from the surface of the copper foil 1, thus forming a dielectric that is strong against mechanical stress and has a high dielectric constant and hence manufacturing a capacitor that is suited for the manufacturing process of the printed-wiring multilayer board and has a large capacity.



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CLAIMS

[Claim(s)]

[Claim 1] The circuit board which has the circuit pattern of the metallic foil containing the 1st electrode of a capacitor on a front face, It has the dielectric of said capacitor formed in the front face of said 1st electrode, and the 2nd electrode of said capacitor formed in the front face of said dielectric. Said dielectric So that it consists of an organic inorganic complex-dielectrics layer containing a metallic-oxide particle and an organic macromolecule, and it may become small as the consistency of said metallic-oxide particle is large on the front face of said 1st electrode and it separates from the front face of said 1st electrode The circuit board with a built-in capacitor characterized by existing in a consistency with an inclination in said organic inorganic complex-dielectrics layer.

[Claim 2] The circuit board according to claim 1 with a built-in capacitor characterized by the particle size of a metallic-oxide particle being 0.05-3 micrometers.

[Claim 3] The circuit board according to claim 1 or 2 with a built-in capacitor characterized by the principal components of a metallic-oxide particle being ferroelectrics, such as titanium oxide and barium titanate.

[Claim 4] Said aluminum oxide which a metallic-oxide particle is a particle which coated the front face of a metallic oxide with the aluminum oxide, and is coated is the circuit board according to claim 1, 2, or 3 with a built-in capacitor characterized by being 1 - 10 % of the weight to said metallic-oxide particle.

[Claim 5] The circuit board according to claim 1, 2, 3, or 4 with a built-in capacitor characterized by organic giant molecules being polycarboxylic acid system resin, polyamine system resin, or the polyimide system resin.

[Claim 6] The circuit board according to claim 1, 2, 3, 4, or 5 with a built-in capacitor characterized by pasting up said circuit board which formed said capacitor, and other circuit boards on a front face through said capacitor.

[Claim 7] The manufacture approach of the circuit board with a built-in capacitor of having the process which is immersed in the suspension of a metallic-oxide particle in the circuit board which has the circuit pattern of the metallic foil containing the electrode of a capacitor on a front face, and forms a metallic-oxide particle layer in the position of said electrode according to electrodeposition, and the process which forms an organic giant molecule in the front face of this metallic-oxide particle layer according to electrodeposition.

[Claim 8] The manufacture approach of the circuit board according to claim 7 with a built-in capacitor characterized by containing in the suspension of a metallic-oxide particle the polyamine derivative which has the double bond of carbon and oxygen as a binder five to 20% of the weight to a metallic-oxide particle.

[Claim 9] The manufacture approach of the circuit board according to claim 7 or 8 with a built-in capacitor that a metallic-oxide particle is characterized by being 1 - 20% in a weight ratio to deionized water.

[Claim 10] The manufacture approach of the circuit board according to claim 7, 8, or 9 with a built-in capacitor characterized by forming an organic giant molecule, without drying this metallic-oxide particle layer after forming a metallic-oxide particle layer.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the circuit board with a built-in capacitor used for the electronic circuitry of an electrical machinery and apparatus, electronic equipment, and an audio equipment etc., and its manufacture approach.
[0002]
[Description of the Prior Art] In recent years, the requests of the miniaturization to electronic parts and the formation of high performance-ized high-reliability have been mounting increasingly with a miniaturization, thin-shape-izing and lightweight-izing of a device, and the densification and digitization of an electrical machinery and apparatus circuit. In such the situation, what has large capacity by small [with the same said of a capacitor] is demanded.
[0003] However, the area which mounting components, such as a capacitor, occupy on a printed-circuit board is still large. This becomes a serious failure at the time of carrying out the further miniaturization of electronic equipment from now on. In order to solve such a problem, the attempt which builds electronic parts, such as a capacitor, in the circuit board is made (for example, JP,10-56251,A, JP,11-68321,A).
[0004] On the other hand, with RF-izing and low-battery-izing of IC circuit, supply voltage is changed by the noise and producing malfunction is posing a big problem. The reason which such a problem produces is that the permission range of fluctuation of supply voltage is becoming small with low-battery-izing of supply voltage. In order to prevent malfunction by the high frequency noise, the capacitor is usually installed in the circumference of a power source. The capacitor used for such an application is called a bypass capacitor and a decoupling capacitor, and a high frequency noise is removed or it is serving to prevent the momentary fall of supply voltage by momentary energy supply from a capacitor. In this energy supply, a role with the important magnitude of the electrostatic capacity of a capacitor is played.
[0005] Although the resistance component and the inductance component of the ideal capacitor must be only electrostatic-capacity components in 0, an actual capacitor has a series resistance component and a serial inductance component. The impedance of a capacity component decreases with the increment in a frequency, and an inductance component increases with the increment in a frequency. For this reason, it is expected that the inductance component which a component has, and the inductance component by wiring cause a noise as clock frequency will become high from now on. Since it is such, it is necessary to make it function as a capacitor to a high frequency region certainly by using as a capacitor what has an inductance component small as much as possible, and making self-resonant frequency of the capacitor itself high. Moreover, the mounting position of a decoupling capacitor is so good that **** [a mounting position / CPU] in order to make the inductance component by wiring distance as small as possible.
[0006] On the other hand, with low-battery-izing of the above supply voltage, the operating rated voltage of the capacitor to install can be smaller future still, and can respond now.
[0007] Since the technical problem of the above high-frequency-izing of IC circuit and low-battery-izing is coped with, the capacitor of high performance is laid under the interior of a printed-circuit board, and some proposals which were going to shorten wiring distance between CPU and a capacitor as much as possible are indicated (for example, refer to JP,4-211191,A, JP,10-335178,A, and JP,11-111561,A).
[0008] In order to expand the miniaturization of the above electronic equipment, and improvement in the speed of a circuit by leaps and bounds from now on, it is indispensable to build in the capacitor of high performance in a printed-circuit board. Moreover, there is also a merit which can reduce mounting expense by making a capacitor build in.
[0009] Some proposals, such as a proposal (for example, refer to JP,4-211191,A, JP,11-68321,A, JP,8-181453,A, JP,10-335178,A, and JP,11-111561,A) which built the capacitor which has the high dielectric constant dielectric of an inorganic substance system in the ceramic substrate by current, and a proposal (for example, refer to JP,8-125302,A, JP,8-242055,A, and JP,10-56251,A) which built the capacitor in the resin substrate, are indicated.
[0010] The mainstream of the charge of a printed-circuit radical plate in the small pocket device represented by current and the cellular phone is a resin substrate. a resin substrate — some flexibility — it is — a high frequency property — excelling — in addition — and to build in the capacitor which has various electrostatic capacity is desired.
[0011] In the proposal indicated until now, there was much what embeds the ingredient of a ceramic system which

needs elevated-temperature baking as a dielectric at a ceramic substrate (for example, refer to JP,8-222656,A and JP,8-181453,A). However, when it builds a capacitor in a resin substrate, after forming in a substrate the ceramic system paste which serves as a dielectric from baking, it is impossible to calcinate at an elevated temperature the whole resin substrate. Therefore, the time and effort that the ceramic condenser of an item must be embedded was required for the resin substrate at the posterior matter. moreover, a common high dielectric constant ceramic system dielectric -- a GHz band -- a dielectric constant -- large -- falling -- in addition -- and since a not good thing also had much temperature characteristic, examination of a property was required for the application with a built-in substrate.

[0012] Moreover, a through tube is prepared in a resin substrate, it is filled up with a dielectric there, and the configuration of the substrate which added the function of a capacitor is indicated by JP,10-56251,A. this approach -- a part for the thickness of a resin substrate -- since all must be boiled and it must be filled up with a dielectric, a dielectric is expected that it was difficult to become thick inevitably and to obtain big electrostatic capacity from two things that only the surface integral of a hole functions as a capacitor. Moreover, by changing the area of a hole or changing the dielectric constant of packing, in order to make a capacitor with various electrostatic capacity to coincidence, time-consuming actuation is needed.

[0013] Many of resin substrates by which current use is carried out form the circuit pattern by etching copper foil into a resin substrate, after pressurizing and hot press pasting up copper foil. Moreover, when pasting up two or more substrates which stretched copper foil and making it a multilayer, between substrate layers is electrically connected through the conductive matter with which the beer hall established in the substrate and the through hole were filled up. When it builds a capacitor in such a resin substrate, the approach which builds in the capacitor which is easy to suit the manufacture process of a resin substrate, and does not raise a manufacturing cost is desirable.

[0014]

[Problem(s) to be Solved by the Invention] However, if it is going to build the capacitor of an item in the above resin substrates according to an individual, the process which provides the clipping tooth space for embedding a capacitor will be needed for a substrate ingredient, and it will become cost quantity.

[0015] Furthermore, at the time of the press at the time of resin substrate manufacture, a dielectric is weak, and may be destroyed and it is not suitable on the manufacture process to use an inorganic oxide thin film like [since big mechanical stress starts] an aluminum oxide or tantalum pentoxide as a dielectric which is indicated by JP,6-181369,A.

[0016] Moreover, control of the thickness of a dielectric is difficult for the approach of applying a dielectric paste to the copper foil pasted up on the substrate like the publication to JP,8-125302,A and JP,8-242055,A, and forming a capacitor, electrostatic capacity is enlarged or it is expected that it was difficult to take out capacity precision.

[0017] The purpose of this invention is offering the circuit board with a built-in capacitor which solves the above-mentioned conventional trouble, suited the manufacture process of a printed-circuit multilayer substrate, and built in the capacitor of high capacity, and its manufacture approach.

[0018]

[Means for Solving the Problem] In order to attain the above-mentioned purpose the circuit board with a built-in capacitor of this invention The circuit board which has the circuit pattern of the metallic foil containing the 1st electrode of a capacitor on a front face, It has the dielectric of the capacitor formed in the front face of the 1st electrode, and the 2nd electrode of the capacitor formed in the front face of a dielectric. A dielectric It is characterized by existing in a consistency with an inclination in an organic inorganic complex-dielectrics layer so that it consists of an organic inorganic complex-dielectrics layer containing a metallic-oxide particle and an organic macromolecule, and a metallic-oxide particle may become small as the consistency is large and separates from the front face of the 1st electrode on the front face of the 1st electrode. By this configuration, strongly, it can consider as a dielectric with a high dielectric constant, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in in mechanical stress.

[0019] In addition, the consistency of the metallic-oxide particle in an organic inorganic complex-dielectrics layer is not restricted when becoming small linearly in proportion to the distance from the 1st electrode of a capacitor.

[0020] Moreover, it is desirable from the flexibility (flexibility) of a dielectric, and the point of a dielectric constant that the particle size of a metallic-oxide particle is 0.05-3 micrometers. Since a metallic-oxide particle becomes dense too much and an organic macromolecule cannot enter in a metallic-oxide particle layer well if the particle size of a metallic-oxide particle is smaller than 0.05 micrometers, the flexibility of a dielectric is lost. Conversely, since a clearance will increase in a metallic-oxide particle layer if the particle size of a metallic-oxide particle is larger than 3 micrometers, a dielectric constant does not become large.

[0021] Moreover, a mass capacitor can be built in when the principal components of a metallic-oxide particle are ferroelectrics, such as titanium oxide and barium titanate.

[0022] Moreover, by being the particle to which coating of the front face of a metallic oxide was carried out to the metallic-oxide particle with 1 - 10% of the weight of the aluminum oxide, a metallic-oxide particle is homogeneous and can produce a metallic-oxide particle layer with a high dielectric constant. Since the dielectric constant of an aluminum oxide is small compared with the metallic oxide which consists of ferroelectrics, such as titanium oxide, although dispersibility becomes good when the front face of a metallic oxide is coated with the high aluminum oxide of a hydrophilic property, as the coating thickness of an aluminum oxide becomes thick, the dielectric constant of a metallic-oxide particle becomes smaller. Therefore, the thinner possible one of coating is good and its 1 - 10 % of the weight is good to a metallic-oxide particle.

[0023] Moreover, since an organic giant molecule is polycarboxylic acid system resin, polyamine system resin, or polyimide system resin, it can consider as a flexible high capacitor.
[0024] Moreover, even if it pastes up the circuit board which formed the capacitor on the surface of the ****, and other circuit boards through a capacitor, since it is strong to mechanical stress as mentioned above, a capacitor property does not get worse.
[0025] Moreover, the manufacture approach of the circuit board with a built-in capacitor of this invention is immersed in the suspension of a metallic-oxide particle in the circuit board which has the circuit pattern of the metallic foil containing the electrode of a capacitor on a front face, and it has the process which forms a metallic-oxide particle layer in the position of an electrode according to electrodeposition, and the process which forms an organic macromolecule in the front face of this metallic-oxide particle layer according to electrodeposition. The organic inorganic complex-dielectrics layer which became small can be formed as it is large and separates from that electrode surface by this manufacture approach in the electrode surface in which the consistency of a metallic-oxide particle forms it, by this, it can consider to mechanical stress as a dielectric with a high dielectric constant strongly, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in.
[0026] Moreover, the suspension of a metallic-oxide particle with sufficient dispersibility can be adjusted by containing in the suspension of a metallic-oxide particle the polyamine derivative which has the double bond of carbon and oxygen as a binder five to 20% of the weight to a metallic-oxide particle. Although dispersibility of a metallic-oxide particle can be improved by adding the binder of the polyamine system which has the double bond of carbon and oxygen to the suspension of a metallic-oxide particle, since a binder is preferentially electrodeposited when [than 20 % of the weight] more [it is almost ineffective to a metallic-oxide particle if fewer than 5 % of the weight, and], as binder concentration, 5 - 20 % of the weight is good to a metallic-oxide particle.
[0027] Moreover, in the suspension of a metallic-oxide particle, a metallic-oxide particle can form a metallic-oxide particle layer thinly to deionized water by being 1 - 20 % of the weight in a weight ratio. When metallic-oxide particle concentration is 1 or less % of the weight, a metallic-oxide particle layer will not be able to be formed according to electrodeposition, but a metallic-oxide particle will precipitate with time amount at 20 % of the weight or more, without distributing well.
[0028] Moreover, without drying this metallic-oxide particle layer, by forming an organic macromolecule, the crack of a metallic-oxide particle layer is prevented, and the leakage current is small and can produce the circuit board which built in the capacitor with a big capacity after forming a metallic-oxide particle layer.
[0029]
[Embodiment of the Invention] Hereafter, it explains, referring to a drawing about the gestalt of operation of this invention.
[0030] Drawing 1 is the sectional view of the circuit board with a built-in capacitor of the gestalt of operation of this invention. For the organic inorganic complex-dielectrics layer in which 1 was formed in of copper foil and 2 was formed of electrodeposition, the counter electrode in which 3 was formed by copper plating, and 4, as for an inner beer hall and 6, in drawing 1 , the insulating substrate of prepreg and 5 are [a metallic-oxide particle and 7] organic macromolecules.
[0031] The circuit board with a built-in capacitor of the gestalt of this operation pastes up the insulating substrate 4 of the prepreg of two or more sheets in which the circuit pattern was formed by copper foil 1, and shows the insulating substrate 4 (4a, 4b, 4c) of three sheets to the example by drawing 1 . The capacitor by which a part of copper foil 1 pasted up on insulating-substrate 4a serves as one electrode of a capacitor, and it consists of the electrode section, an organic inorganic complex-dielectrics layer 2, and a counter electrode 3 was formed in insulating-substrate 4a, and insulating-substrate 4b has pasted up so that the capacitor may be inserted.
[0032] The metallic-oxide particle 6 in the organic inorganic complex-dielectrics layer 2 exists [in the organic inorganic complex-dielectrics layer 2] from the copper foil 1 neighborhood with the inclination of a consistency to secret ** in the counter electrode 3 direction so that the organic inorganic complex-dielectrics layer 2 which is the dielectric of this capacitor consists of a metallic-oxide particle 6 and an organic macromolecule 7, and that consistency may become small as it is large on copper foil 1 front face and separates from copper foil 1 front face. The metallic-oxide particle 6 is a particle which coated with the aluminum oxide the front face of the metallic oxide which are ferroelectrics, such as titanium oxide and barium titanate.
[0033] In addition, when using the insulating substrate 4 (4a, 4b, 4c) of three sheets, sequential adhesion of every one insulating substrate may be carried out, and you may make it paste three-sheet coincidence in piles like drawing 1 .
[0034] Moreover, although copper foil 1 is used for the circuit pattern containing one electrode of a capacitor, other metallic foils, such as aluminum foil, and a conductor can be used.
[0035]
[Example] About the circuit board with a built-in capacitor like drawing 1 , each following example explains the concrete example of a configuration and its manufacture approach. In addition, each following example explains the capacitor internal-organs circuit board which the insulating substrate of the prepreg of two sheets pasted up.
[0036] (Example 1) It is the configuration using UV hardening mold cation system resin as an organic giant molecule 7 using the titanium oxide particle which coated the front face with this example 1 with the aluminum oxide as a metallic-oxide particle 6 in the capacitor of drawing 1 .
[0037] The manufacture approach in this case is explained to a detail using the order sectional view of a process of

drawing 2 .
[0038] First, the copper foil 1 which carried out surface roughening of the epoxy system resin to the insulating substrate 4 of the prepreg which sank in was pasted up on the aramid fiber with heating / pressurization press at step 1 (drawing 2 (a), (b)). That in which the inner beer hall 5 where it filled up with the copper paste beforehand was formed was used for the insulating substrate 4 of this prepreg.
[0039] Next, at step 2, the garbage of copper foil 1 was etched with the ferric-chloride solution, and the circuit pattern containing one electrode of a capacitor was formed (drawing 2 (c)).
[0040] Next, the titanium oxide particle was deposited on the copper foil 1 of the electrode section of a capacitor by immersing copper foil 1 in the titanium oxide suspension water solution (a polyamine system binder being contained 0.25% of the weight) which contains the titanium oxide particle (0.1 micrometers of mean diameters) which carried out hydrophilization processing of the front face with oxidization aluminum 2.5% of the weight, and impressing 10V by using a carbon plate as an anode at step 3, using the copper foil 1 as a cathode. Next, it was immersed into UV hardening mold cation system plastic paint as it is, without drying this titanium oxide particle layer, it impressed 15V by having used the carbon plate as the anode, having used copper foil 1 as the cathode, and on the titanium oxide particle layer (6), the organic macromolecule 7 was deposited, after predrying, it was made to harden by UV irradiation and the organic inorganic complex-dielectrics layer 2 was formed. By electrolytic copper [non-] plating and performing electrolytic copper plating continuously on this complex-dielectrics layer 2, the counter electrode 3 was formed and the thin capacitor was produced (drawing 2 (d)).
[0041] In addition, although only a part with predetermined copper foil 1 is deposited as shown by the organic inorganic complex-dielectrics layer 2 of (d) of drawing 2 in case a titanium oxide particle (6) and the organic macromolecule 7 are deposited, this makes a mask a part not to electrodeposit and performs it. A resist, a masking seal, etc. are used as a masking reagent.
[0042] Next, at step 4, the insulating substrate 4 by which the thin capacitor was produced was pasted up with the insulating substrate 4 of prepreg and heating / pressurization press which copper foil 1 has pasted up on one side beforehand, and the circuit board with a built-in capacitor was produced (drawing 2 R> 2 (e)). In addition, the conditions at the time of pasting up were made into with a pressure of 50x9.8Ns [/cm] 2 (50 kgf/cm2) and temperature of 200 degrees C, and holding-time 60 minutes under the vacuum ambient atmosphere. In addition, on the occasion of adhesion, it pressed by carrying out alignment so that a flow with a thin capacitor and the copper paste in the inner beer hall 5 of the insulating substrate 4 of the bottom in drawing 2 (e) could be taken enough. In addition, the front face of the insulating substrate 4 of the bottom before pasting up the insulating substrate 4 of the upper and lower sides of drawing 2 (e) is flat, and an upper capacitor came to have sunk into the front face of the insulating substrate 4 of lower prepreg.
(Example 2) It is the configuration using UV hardening mold cation system resin using the barium titanate particle which coated the front face with this example 2 with the aluminum oxide as a metallic-oxide particle 4 in the capacitor of drawing 1 like an example 1 as an organic giant molecule 7.
[0043] The manufacture approach in this case produced the circuit board with a built-in capacitor according to the example 1 except having used the barium titanate particle which coated the front face with the aluminum oxide and carried out hydrophilization processing instead of the titanium oxide particle which coated the front face in an example 1 with the aluminum oxide, and carried out hydrophilization processing.
[0044] (Example 3) In this example 3, it is the same configuration as an example 1 as an organic giant molecule 7 except having used heat-curing mold cation system resin.
[0045] The manufacture approach in this case produced the circuit board with a built-in capacitor according to the example 1 except having used heat-curing mold cation system resin for the electrodeposted resin solution which forms the organic giant molecule 7 instead of UV hardening mold cation system resin in an example 1. In this case, it was immersed into heat-curing mold cation system plastic paint as it is, without drying the copper foil 1 in which the titanium oxide particle layer was made to form like an example 1, it impressed 20V by having used the carbon plate as the anode, having used copper foil 1 as the cathode, and on the titanium oxide particle layer, the organic macromolecule 7 was deposited, after predrying, it was made to harden at 150 degrees C for 20 minutes, and the organic inorganic compound dielectric layer 2 was formed.
[0046] As an example 1 of a comparison, since a titanium oxide particle is made to electrodeposit in formation of the dielectric of a capacitor and this was dried, according to the example 1, the circuit board with a built-in capacitor was produced except having deposited the organic giant molecule and having formed the organic inorganic complex-dielectrics layer.
[0047] As an example 2 of a comparison, after making a titanium oxide particle layer form in formation of the dielectric of a capacitor, according to the example 1, the circuit board with a built-in capacitor was produced except having not stepped on the process of making an organic giant molecule form, but having made organic giant-molecule electrodeposition liquid suspend a titanium oxide particle, and having carried out the organic inorganic complex-dielectrics stratification at once.
[0048] The result of having investigated each capacitor property (the electrostatic-capacity C:unit nF, loss-value tandelta: unit %) built in the circuit board with a built-in capacitor produced as mentioned above in examples 1-3 and the examples 1 and 2 of a comparison is shown in Table 1. This is the result of measuring by 1kHz of test frequencies using an LCR meter (for example, HP4274A). In addition, in each example and each example of a comparison, the three circuit boards with a built-in capacitor are produced, respectively, and the average of three capacitors built in each is shown in Table 1.

[0049]
[Table 1]

	C／nF（1 kHz）	tan δ ／%（1 kHz）
実施例 1	5.63	3.56
実施例 2	12.9	3.88
実施例 3	5.51	3.05
比較例 1	0.01	33.4
比較例 2	1.18	23.1

対極の面積：1 cm× 1 cm= 1 cm^2

[0050] The capacity (C) of the capacitor of the example 1 of a comparison and the example 2 of a comparison was small, tandelta showing a loss value was large and its capacitor property was bad so that clearly from this table 1. Before pressurization and hot press, since the value of tandelta was 3 - 4% (1kHz), it is considered that the capacitor property got worse by pressurization and hot press. On the other hand, as for the property, pressurization and hot press did not get worse, either, but, as for the capacitor by this examples 1-3, the result very strong against mechanical stress was obtained.
[0051] As mentioned above, according to the gestalt and example of this operation, the metallic-oxide particle 6 of the organic inorganic complex-dielectrics layer 2 of a capacitor so that it may become small as it is large and separates from the front face of the electrode on the front face of the electrode with which the consistency consists of copper foil 1 By making it exist in a consistency with an inclination in the organic inorganic complex-dielectrics layer 2, strongly, it can consider as a dielectric with a high dielectric constant, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in in mechanical stress.
[0052] Moreover, it is desirable from the flexibility (flexibility) of a dielectric, and the point of a dielectric constant that the particle size of the metallic-oxide particle 6 is 0.05-3 micrometers. Since the metallic-oxide particle 6 becomes dense too much and the organic macromolecule 7 cannot enter in a metallic-oxide particle layer well if the particle size of the metallic-oxide particle 6 is smaller than 0.05 micrometers, the flexibility of a dielectric is lost. Conversely, since a clearance will increase in a metallic-oxide particle layer if the particle size of the metallic-oxide particle 6 is larger than 3 micrometers, a dielectric constant does not become large.
[0053] Moreover, a mass capacitor can be built in when the principal components of the metallic-oxide particle 6 are ferroelectrics, such as titanium oxide and barium titanate, like examples 1-3.
[0054] Moreover, by being the particle to which coating of the front face of a metallic oxide was carried out to the metallic-oxide particle 6 with 1 - 10% of the weight of the aluminum oxide, the metallic-oxide particle 6 is homogeneous and can produce a metallic-oxide particle layer with a high dielectric constant. Since the dielectric constant of an aluminum oxide is small compared with the metallic oxide which consists of ferroelectrics, such as titanium oxide, although dispersibility becomes good when the front face of a metallic oxide is coated with the high aluminum oxide of a hydrophilic property, as the coating thickness of an aluminum oxide becomes thick, the dielectric constant of a metallic-oxide particle becomes smaller. Therefore, the thinner possible one of coating is good and its 1 - 10 % of the weight is good to the metallic-oxide particle 6.
[0055] Moreover, since the organic giant molecule 7 is polycarboxylic acid system resin, polyamine system resin, or polyimide system resin, it can consider as a flexible high capacitor. Although the cation system resin of UV hardening mold or a heat-curing mold was used as an organic giant molecule 7 in the example, these are the examples which used polyamine system resin.
[0056] Moreover, by being immersed in the suspension of a metallic-oxide particle, forming a metallic-oxide particle layer in the copper foil 1 of an electrode section according to electrodeposition like the manufacture approach of the above-mentioned example, and forming the organic macromolecule 7 according to electrodeposition after that The organic inorganic complex-dielectrics layer 2 which became small as it was large and separated from the electrode surface in the electrode surface in which the consistency of the metallic-oxide particle 6 forms it can be formed. By this Strongly, it can consider as a dielectric with a high dielectric constant, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in in mechanical stress.
[0057] Moreover, the suspension of a metallic-oxide particle with sufficient dispersibility can be adjusted by containing in the suspension of a metallic-oxide particle the polyamine derivative which has the double bond of carbon and oxygen as a binder five to 20% of the weight to the metallic-oxide particle 6. Although dispersibility of the metallic-oxide particle 6 can be improved by adding the binder of the polyamine system which has the double bond of carbon and oxygen to the suspension of a metallic-oxide particle, since a binder is preferentially electrodeposited when [than 20 % of the weight] more [it is almost ineffective to the metallic-oxide particle 6 if fewer than 5 % of the weight, and], as binder concentration, 5 - 20 % of the weight is good to the metallic-oxide particle 6.
[0058] Moreover, although the suspension of a metallic-oxide particle makes deionized water distribute a metallic-oxide particle, in this suspension, the metallic-oxide particle 6 can form a metallic-oxide particle layer thinly to deionized water by being 1 - 20 % of the weight in a weight ratio. When metallic-oxide particle concentration is 1 or less % of the weight, a metallic-oxide particle layer will not be able to be formed according to electrodeposition, but the metallic-oxide particle 6 will precipitate with time amount at 20 % of the weight or more, without distributing well.

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[0059] Moreover, without drying this metallic-oxide particle layer, by forming the organic macromolecule 7, the crack of a metallic-oxide particle layer is prevented, and the leakage current is small and can produce a capacitor with a big capacity after forming a metallic-oxide particle layer.
[0060] moreover, the metallic-oxide particle layer which consists of a metallic-oxide particle 6 with a high dielectric constant by changing electrodeposted time amount and electrodeposted potential and the organic giant molecule 7 — since each thickness can be adjusted, a dielectric constant and the capacitor which controlled pressure-proofing can be obtained easily.
[0061] Moreover, as a counter electrode 3, vacuum evaporationo of metal plating, such as nickel besides copper plating and a conductive polymer, aluminum, zinc, etc. is sufficient.
[0062]
[Effect of the Invention] The circuit board which has the circuit pattern of a metallic foil with which the circuit board with a built-in capacitor of this invention contains the 1st electrode of a capacitor on a front face, It has the dielectric of the capacitor formed in the front face of the 1st electrode, and the 2nd electrode of the capacitor formed in the front face of a dielectric. A dielectric So that it consists of an organic inorganic complex-dielectrics layer containing a metallic-oxide particle and an organic macromolecule, and it may become small as the consistency of a metallic-oxide particle is large on the front face of the 1st electrode and it separates from the front face of the 1st electrode It exists in a consistency with an inclination in an organic inorganic complex-dielectrics layer, and by this configuration, strongly, it can consider as a dielectric with a high dielectric constant, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in in mechanical stress.
[0063] Moreover, it is desirable, when it is excellent in the flexibility (flexibility) of a dielectric that the particle size of a metallic-oxide particle is 0.05-3 micrometers and it makes a dielectric constant high.
[0064] Moreover, a mass capacitor can be built in when the principal components of a metallic-oxide particle are ferroelectrics, such as titanium oxide and barium titanate.
[0065] Moreover, by being the particle to which coating of the front face of a metallic oxide was carried out to the metallic-oxide particle with 1 - 10% of the weight of the aluminum oxide, a metallic-oxide particle is homogeneous and can produce a metallic-oxide particle layer with a high dielectric constant.
[0066] Moreover, since an organic giant molecule is polycarboxylic acid system resin, polyamine system resin, or polyimide system resin, it can consider as a flexible high capacitor.
[0067] Moreover, even if it pastes up the circuit board which formed the capacitor on the surface of the ****, and other circuit boards through a capacitor, since it is strong to mechanical stress as mentioned above, a capacitor property does not get worse.
[0068] Moreover, the manufacture approach of the circuit board with a built-in capacitor of this invention The process which is immersed in the suspension of a metallic-oxide particle in the circuit board which has the circuit pattern of the metallic foil containing the electrode of a capacitor on a front face, and forms a metallic-oxide particle layer in the position of an electrode according to electrodeposition, By having the process which forms an organic macromolecule in the front face of this metallic-oxide particle layer according to electrodeposition The organic inorganic complex-dielectrics layer which became small as it was large and separated from the electrode surface in the electrode surface in which the consistency of a metallic-oxide particle forms it can be formed. By this Strongly, it can consider as a dielectric with a high dielectric constant, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in in mechanical stress.
[0069] Moreover, the suspension of a metallic-oxide particle with sufficient dispersibility can be adjusted by containing in the suspension of a metallic-oxide particle the polyamine derivative which has the double bond of carbon and oxygen as a binder five to 20% of the weight to a metallic-oxide particle.
[0070] Moreover, in the suspension of a metallic-oxide particle, a metallic-oxide particle can form a metallic-oxide particle layer thinly to deionized water by being 1 - 20 % of the weight in a weight ratio.
[0071] Moreover, without drying this metallic-oxide particle layer, by forming an organic macromolecule, the crack of a metallic-oxide particle layer is prevented, and the leakage current is small and can produce the circuit board which built in the capacitor with a big capacity after forming a metallic-oxide particle layer.
[0072] As mentioned above, the manufacture process of a printed-circuit multilayer substrate can be suited, and it can be suitable for a high frequency application, while being able to attain a miniaturization, the circuit board with a built-in capacitor with high productivity can be realized, and it can contribute to much more miniaturization of electronic equipment.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the circuit board with a built-in capacitor used for the electronic circuitry of an electrical machinery and apparatus, electronic equipment, and an audio equipment etc., and its manufacture approach.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In recent years, the requests of the miniaturization to electronic parts and the formation of high performance-ized high-reliability have been mounting increasingly with a miniaturization, thin-shape-izing and lightweight-izing of a device, and the densification and digitization of an electrical machinery and apparatus circuit. In such the situation, what has large capacity by small [with the same said of a capacitor] is demanded.
[0003] However, the area which mounting components, such as a capacitor, occupy on a printed-circuit board is still large. This becomes a serious failure at the time of carrying out the further miniaturization of electronic equipment from now on. In order to solve such a problem, the attempt which builds electronic parts, such as a capacitor, in the circuit board is made (for example, JP,10-56251,A, JP,11-68321,A).
[0004] On the other hand, with RF-izing and low-battery-izing of IC circuit, supply voltage is changed by the noise and producing malfunction is posing a big problem. The reason which such a problem produces is that the permission range of fluctuation of supply voltage is becoming small with low-battery-izing of supply voltage. In order to prevent malfunction by the high frequency noise, the capacitor is usually installed in the circumference of a power source. The capacitor used for such an application is called a bypass capacitor and a decoupling capacitor, and a high frequency noise is removed or it is serving to prevent the momentary fall of supply voltage by momentary energy supply from a capacitor. In this energy supply, a role with the important magnitude of the electrostatic capacity of a capacitor is played.
[0005] Although the resistance component and the inductance component of the ideal capacitor must be only electrostatic-capacity components in 0, an actual capacitor has a series resistance component and a serial inductance component. The impedance of a capacity component decreases with the increment in a frequency, and an inductance component increases with the increment in a frequency. For this reason, it is expected that the inductance component which a component has, and the inductance component by wiring cause a noise as clock frequency will become high from now on. Since it is such, it is necessary to make it function as a capacitor to a high frequency region certainly by using as a capacitor what has an inductance component small as much as possible, and making self-resonant frequency of the capacitor itself high. Moreover, the mounting position of a decoupling capacitor is so good that **** [a mounting position / CPU] in order to make the inductance component by wiring distance as small as possible.
[0006] On the other hand, with low-battery-izing of the above supply voltage, the operating rated voltage of the capacitor to install can be smaller future still, and can respond now.
[0007] Since the technical problem of the above high-frequency-izing of IC circuit and low-battery-izing is coped with, the capacitor of high performance is laid under the interior of a printed-circuit board, and some proposals which were going to shorten wiring distance between CPU and a capacitor as much as possible are indicated (for example, refer to JP,4-211191,A, JP,10-335178,A, and JP,11-111561,A).
[0008] In order to expand the miniaturization of the above electronic equipment, and improvement in the speed of a circuit by leaps and bounds from now on, it is indispensable to build in the capacitor of high performance in a printed-circuit board. Moreover, there is also a merit which can reduce mounting expense by making a capacitor build in.
[0009] Some proposals, such as a proposal (for example, refer to JP,4-211191,A, JP,11-68321,A, JP,8-181453,A, JP,10-335178,A, and JP,11-111561,A) which built the capacitor which has the high dielectric constant dielectric of an inorganic substance system in the ceramic substrate by current, and a proposal (for example, refer to JP,8-125302,A, JP,8-242055,A, and JP,10-56251,A) which built the capacitor in the resin substrate, are indicated.
[0010] The mainstream of the charge of a printed-circuit radical plate in the small pocket device represented by current and the cellular phone is a resin substrate. a resin substrate — some flexibility — it is — a high frequency property — excelling — in addition — and to build in the capacitor which has various electrostatic capacity is desired.
[0011] In the proposal indicated until now, there was much what embeds the ingredient of a ceramic system which needs elevated-temperature baking as a dielectric at a ceramic substrate (for example, refer to JP,8-222656,A and JP,8-181453,A). However, when it builds a capacitor in a resin substrate, after forming in a substrate the ceramic system paste which serves as a dielectric from baking, it is impossible to calcinate at an elevated temperature the whole resin substrate. Therefore, the time and effort that the ceramic condenser of an item must be embedded was required for the resin substrate at the posterior matter. moreover, a common high dielectric constant ceramic system dielectric — a GHz band — a dielectric constant — large — falling — in addition — and since a not good

thing also had much temperature characteristic, examination of a property was required for the application with a built-in substrate.

[0012] Moreover, a through tube is prepared in a resin substrate, it is filled up with a dielectric there, and the configuration of the substrate which added the function of a capacitor is indicated by JP,10-56251,A. this approach -- a part for the thickness of a resin substrate -- since all must be boiled and it must be filled up with a dielectric, a dielectric is expected that it was difficult to become thick inevitably and to obtain big electrostatic capacity from two things that only the surface integral of a hole functions as a capacitor. Moreover, by changing the area of a hole or changing the dielectric constant of packing, in order to make a capacitor with various electrostatic capacity to coincidence, time-consuming actuation is needed.

[0013] Many of resin substrates by which current use is carried out form the circuit pattern by etching copper foil into a resin substrate, after pressurizing and hot press pasting up copper foil. Moreover, when pasting up two or more substrates which stretched copper foil and making it a multilayer, between substrate layers is electrically connected through the conductive matter with which the beer hall established in the substrate and the through hole were filled up. When it builds a capacitor in such a resin substrate, the approach which builds in the capacitor which is easy to suit the manufacture process of a resin substrate, and does not raise a manufacturing cost is desirable.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] The circuit board which has the circuit pattern of a metallic foil with which the circuit board with a built-in capacitor of this invention contains the 1st electrode of a capacitor on a front face, It has the dielectric of the capacitor formed in the front face of the 1st electrode, and the 2nd electrode of the capacitor formed in the front face of a dielectric. A dielectric So that it consists of an organic inorganic complex-dielectrics layer containing a metallic-oxide particle and an organic macromolecule, and it may become small as the consistency of a metallic-oxide particle is large on the front face of the 1st electrode and it separates from the front face of the 1st electrode It exists in a consistency with an inclination in an organic inorganic complex-dielectrics layer, and by this configuration, strongly, it can consider as a dielectric with a high dielectric constant, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in in mechanical stress.
[0063] Moreover, it is desirable, when it is excellent in the flexibility (flexibility) of a dielectric that the particle size of a metallic-oxide particle is 0.05-3 micrometers and it makes a dielectric constant high.
[0064] Moreover, a mass capacitor can be built in when the principal components of a metallic-oxide particle are ferroelectrics, such as titanium oxide and barium titanate.
[0065] Moreover, by being the particle to which coating of the front face of a metallic oxide was carried out to the metallic-oxide particle with 1 - 10% of the weight of the aluminum oxide, a metallic-oxide particle is homogeneous and can produce a metallic-oxide particle layer with a high dielectric constant.
[0066] Moreover, since an organic giant molecule is polycarboxylic acid system resin, polyamine system resin, or polyimide system resin, it can consider as a flexible high capacitor.
[0067] Moreover, even if it pastes up the circuit board which formed the capacitor on the surface of the ****, and other circuit boards through a capacitor, since it is strong to mechanical stress as mentioned above, a capacitor property does not get worse.
[0068] Moreover, the manufacture approach of the circuit board with a built-in capacitor of this invention The process which is immersed in the suspension of a metallic-oxide particle in the circuit board which has the circuit pattern of the metallic foil containing the electrode of a capacitor on a front face, and forms a metallic-oxide particle layer in the position of an electrode according to electrodeposition, By having the process which forms an organic macromolecule in the front face of this metallic-oxide particle layer according to electrodeposition The organic inorganic complex-dielectrics layer which became small as it was large and separated from the electrode surface in the electrode surface in which the consistency of a metallic-oxide particle forms it can be formed. By this Strongly, it can consider as a dielectric with a high dielectric constant, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in in mechanical stress.
[0069] Moreover, the suspension of a metallic-oxide particle with sufficient dispersibility can be adjusted by containing in the suspension of a metallic-oxide particle the polyamine derivative which has the double bond of carbon and oxygen as a binder five to 20% of the weight to a metallic-oxide particle.
[0070] Moreover, in the suspension of a metallic-oxide particle, a metallic-oxide particle can form a metallic-oxide particle layer thinly to deionized water by being 1 - 20 % of the weight in a weight ratio.
[0071] Moreover, without drying this metallic-oxide particle layer, by forming an organic macromolecule, the crack of a metallic-oxide particle layer is prevented, and the leakage current is small and can produce the circuit board which built in the capacitor with a big capacity after forming a metallic-oxide particle layer.
[0072] As mentioned above, the manufacture process of a printed-circuit multilayer substrate can be suited, and it can be suitable for a high frequency application, while being able to attain a miniaturization, the circuit board with a built-in capacitor with high productivity can be realized, and it can contribute to much more miniaturization of electronic equipment.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, if it is going to build the capacitor of an item in the above resin substrates according to an individual, the process which provides the clipping tooth space for embedding a capacitor will be needed for a substrate ingredient, and it will become cost quantity.
[0015] Furthermore, at the time of the press at the time of resin substrate manufacture, a dielectric is weak, and may be destroyed and it is not suitable on the manufacture process to use an inorganic oxide thin film like [since big mechanical stress starts] an aluminum oxide or tantalum pentoxide as a dielectric which is indicated by JP,6-181369,A.
[0016] Moreover, control of the thickness of a dielectric is difficult for the approach of applying a dielectric paste to the copper foil pasted up on the substrate like the publication to JP,8-125302,A and JP,8-242055,A, and forming a capacitor, electrostatic capacity is enlarged or it is expected that it was difficult to take out capacity precision.
[0017] The purpose of this invention is offering the circuit board with a built-in capacitor which solves the above-mentioned conventional trouble, suited the manufacture process of a printed-circuit multilayer substrate, and built in the capacitor of high capacity, and its manufacture approach.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to attain the above-mentioned purpose the circuit board with a built-in capacitor of this invention The circuit board which has the circuit pattern of the metallic foil containing the 1st electrode of a capacitor on a front face, It has the dielectric of the capacitor formed in the front face of the 1st electrode, and the 2nd electrode of the capacitor formed in the front face of a dielectric. A dielectric It is characterized by existing in a consistency with an inclination in an organic inorganic complex-dielectrics layer so that it consists of an organic inorganic complex-dielectrics layer containing a metallic-oxide particle and an organic macromolecule, and a metallic-oxide particle may become small as the consistency is large and separates from the front face of the 1st electrode on the front face of the 1st electrode. By this configuration, strongly, it can consider as a dielectric with a high dielectric constant, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in in mechanical stress.
[0019] In addition, the consistency of the metallic-oxide particle in an organic inorganic complex-dielectrics layer is not restricted when becoming small linearly in proportion to the distance from the 1st electrode of a capacitor.
[0020] Moreover, it is desirable from the flexibility (flexibility) of a dielectric, and the point of a dielectric constant that the particle size of a metallic-oxide particle is 0.05-3 micrometers. Since a metallic-oxide particle becomes dense too much and an organic macromolecule cannot enter in a metallic-oxide particle layer well if the particle size of a metallic-oxide particle is smaller than 0.05 micrometers, the flexibility of a dielectric is lost. Conversely, since a clearance will increase in a metallic-oxide particle layer if the particle size of a metallic-oxide particle is larger than 3 micrometers, a dielectric constant does not become large.
[0021] Moreover, a mass capacitor can be built in when the principal components of a metallic-oxide particle are ferroelectrics, such as titanium oxide and barium titanate.
[0022] Moreover, by being the particle to which coating of the front face of a metallic oxide was carried out to the metallic-oxide particle with 1 - 10% of the weight of the aluminum oxide, a metallic-oxide particle is homogeneous and can produce a metallic-oxide particle layer with a high dielectric constant. Since the dielectric constant of an aluminum oxide is small compared with the metallic oxide which consists of ferroelectrics, such as titanium oxide, although dispersibility becomes good when the front face of a metallic oxide is coated with the high aluminum oxide of a hydrophilic property, as the coating thickness of an aluminum oxide becomes thick, the dielectric constant of a metallic-oxide particle becomes smaller. Therefore, the thinner possible one of coating is good and its 1 - 10 % of the weight is good to a metallic-oxide particle.
[0023] Moreover, since an organic giant molecule is polycarboxylic acid system resin, polyamine system resin, or polyimide system resin, it can consider as a flexible high capacitor.
[0024] Moreover, even if it pastes up the circuit board which formed the capacitor on the surface of the ****, and other circuit boards through a capacitor, since it is strong to mechanical stress as mentioned above, a capacitor property does not get worse.
[0025] Moreover, the manufacture approach of the circuit board with a built-in capacitor of this invention is immersed in the suspension of a metallic-oxide particle in the circuit board which has the circuit pattern of the metallic foil containing the electrode of a capacitor on a front face, and it has the process which forms a metallic-oxide particle layer in the position of an electrode according to electrodeposition, and the process which forms an organic macromolecule in the front face of this metallic-oxide particle layer according to electrodeposition. The organic inorganic complex-dielectrics layer which became small can be formed as it is large and separates from that electrode surface by this manufacture approach in the electrode surface in which the consistency of a metallic-oxide particle forms it, by this, it can consider to mechanical stress as a dielectric with a high dielectric constant strongly, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in.
[0026] Moreover, the suspension of a metallic-oxide particle with sufficient dispersibility can be adjusted by containing in the suspension of a metallic-oxide particle the polyamine derivative which has the double bond of carbon and oxygen as a binder five to 20% of the weight to a metallic-oxide particle. Although dispersibility of a metallic-oxide particle can be improved by adding the binder of the polyamine system which has the double bond of carbon and oxygen to the suspension of a metallic-oxide particle, since a binder is preferentially electrodeposited when [than 20 % of the weight] more [it is almost ineffective to a metallic-oxide particle if fewer than 5 % of the weight, and], as binder concentration, 5 - 20 % of the weight is good to a metallic-oxide particle.
[0027] Moreover, in the suspension of a metallic-oxide particle, a metallic-oxide particle can form a metallic-oxide particle layer thinly to deionized water by being 1 - 20 % of the weight in a weight ratio. When metallic-oxide particle

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concentration is 1 or less % of the weight, a metallic-oxide particle layer will not be able to be formed according to electrodeposition, but a metallic-oxide particle will precipitate with time amount at 20 % of the weight or more, without distributing well.

[0028] Moreover, without drying this metallic-oxide particle layer, by forming an organic macromolecule, the crack of a metallic-oxide particle layer is prevented, and the leakage current is small and can produce the circuit board which built in the capacitor with a big capacity after forming a metallic-oxide particle layer.

[0029]

[Embodiment of the Invention] Hereafter, it explains, referring to a drawing about the gestalt of operation of this invention.

[0030] Drawing 1 is the sectional view of the circuit board with a built-in capacitor of the gestalt of operation of this invention. For the organic inorganic complex-dielectrics layer in which 1 was formed in of copper foil and 2 was formed of electrodeposition, the counter electrode in which 3 was formed by copper plating, and 4, as for an inner beer hall and 6, in drawing 1 , the insulating substrate of prepreg and 5 are [a metallic-oxide particle and 7] organic macromolecules.

[0031] The circuit board with a built-in capacitor of the gestalt of this operation pastes up the insulating substrate 4 of the prepreg of two or more sheets in which the circuit pattern was formed by copper foil 1, and shows the insulating substrate 4 (4a, 4b, 4c) of three sheets to the example by drawing 1 . The capacitor by which a part of copper foil 1 pasted up on insulating-substrate 4a serves as one electrode of a capacitor, and it consists of the electrode section, an organic inorganic complex-dielectrics layer 2, and a counter electrode 3 was formed in insulating-substrate 4a, and insulating-substrate 4b has pasted up so that the capacitor may be inserted.

[0032] The metallic-oxide particle 6 in the organic inorganic complex-dielectrics layer 2 exists [in the organic inorganic complex-dielectrics layer 2] from the copper foil 1 neighborhood with the inclination of a consistency to secret ** in the counter electrode 3 direction so that the organic inorganic complex-dielectrics layer 2 which is the dielectric of this capacitor consists of a metallic-oxide particle 6 and an organic macromolecule 7, and that consistency may become small as it is large on copper foil 1 front face and separates from copper foil 1 front face. The metallic-oxide particle 6 is a particle which coated with the aluminum oxide the front face of the metallic oxide which are ferroelectrics, such as titanium oxide and barium titanate.

[0033] In addition, when using the insulating substrate 4 (4a, 4b, 4c) of three sheets, sequential adhesion of every one insulating substrate may be carried out, and you may make it paste three-sheet coincidence in piles like drawing 1 .

[0034] Moreover, although copper foil 1 is used for the circuit pattern containing one electrode of a capacitor, other metallic foils, such as aluminum foil, and a conductor can be used.

[Translation done.]

EXAMPLE

[Example] About the circuit board with a built-in capacitor like drawing 1 , each following example explains the concrete example of a configuration and its manufacture approach. In addition, each following example explains the capacitor internal-organs circuit board which the insulating substrate of the prepreg of two sheets pasted up.
[0036] (Example 1) It is the configuration using UV hardening mold cation system resin as an organic giant molecule 7 using the titanium oxide particle which coated the front face with this example 1 with the aluminum oxide as a metallic-oxide particle 6 in the capacitor of drawing 1 .
[0037] The manufacture approach in this case is explained to a detail using the order sectional view of a process of drawing 2 .
[0038] First, the copper foil 1 which carried out surface roughening of the epoxy system resin to the insulating substrate 4 of the prepreg which sank in was pasted up on the aramid fiber with heating / pressurization press at step 1 (drawing 2 (a), (b)). That in which the inner beer hall 5 where it filled up with the copper paste beforehand was formed was used for the insulating substrate 4 of this prepreg.
[0039] Next, at step 2, the garbage of copper foil 1 was etched with the ferric-chloride solution, and the circuit pattern containing one electrode of a capacitor was formed (drawing 2 (c)).
[0040] Next, the titanium oxide particle was deposited on the copper foil 1 of the electrode section of a capacitor by immersing copper foil 1 in the titanium oxide suspension water solution (a polyamine system binder being contained 0.25% of the weight) which contains the titanium oxide particle (0.1 micrometers of mean diameters) which carried out hydrophilization processing of the front face with oxidization aluminum 2.5% of the weight, and impressing 10V by using a carbon plate as an anode at step 3, using the copper foil 1 as a cathode. Next, it was immersed into UV hardening mold cation system plastic paint as it is, without drying this titanium oxide particle layer, it impressed 15V by having used the carbon plate as the anode, having used copper foil 1 as the cathode, and on the titanium oxide particle layer (6), the organic macromolecule 7 was deposited, after predrying, it was made to harden by UV irradiation and the organic inorganic complex-dielectrics layer 2 was formed. By electrolytic copper [non-] plating and performing electrolytic copper plating continuously on this complex-dielectrics layer 2, the counter electrode 3 was formed and the thin capacitor was produced (drawing 2 (d)).
[0041] In addition, although only a part with predetermined copper foil 1 is deposited as shown by the organic inorganic complex-dielectrics layer 2 of (d) of drawing 2 in case a titanium oxide particle (6) and the organic macromolecule 7 are deposited, this makes a mask a part not to electrodeposit and performs it. A resist, a masking seal, etc. are used as a masking reagent.
[0042] Next, at step 4, the insulating substrate 4 by which the thin capacitor was produced was pasted up with the insulating substrate 4 of prepreg and heating / pressurization press which copper foil 1 has pasted up on one side beforehand, and the circuit board with a built-in capacitor was produced (drawing 2 R> 2 (e)). In addition, the conditions at the time of pasting up were made into with a pressure of 50x9.8Ns [/cm] 2 (50 kgf/cm2) and temperature of 200 degrees C, and holding-time 60 minutes under the vacuum ambient atmosphere. In addition, on the occasion of adhesion, it pressed by carrying out alignment so that a flow with a thin capacitor and the copper paste in the inner beer hall 5 of the insulating substrate 4 of the bottom in drawing 2 (e) could be taken enough. In addition, the front face of the insulating substrate 4 of the bottom before pasting up the insulating substrate 4 of the upper and lower sides of drawing 2 (e) is flat, and an upper capacitor came to have sunk into the front face of the insulating substrate 4 of lower prepreg.
(Example 2) It is the configuration using UV hardening mold cation system resin using the barium titanate particle which coated the front face with this example 2 with the aluminum oxide as a metallic-oxide particle 4 in the capacitor of drawing 1 like an example 1 as an organic giant molecule 7.
[0043] The manufacture approach in this case produced the circuit board with a built-in capacitor according to the example 1 except having used the barium titanate particle which coated the front face with the aluminum oxide and carried out hydrophilization processing instead of the titanium oxide particle which coated the front face in an example 1 with the aluminum oxide, and carried out hydrophilization processing.
[0044] (Example 3) In this example 3, it is the same configuration as an example 1 as an organic giant molecule 7 except having used heat-curing mold cation system resin.
[0045] The manufacture approach in this case produced the circuit board with a built-in capacitor according to the example 1 except having used heat-curing mold cation system resin for the electrodeposted resin solution which forms the organic giant molecule 7 instead of UV hardening mold cation system resin in an example 1. In this case, it was immersed into heat-curing mold cation system plastic paint as it is, without drying the copper foil 1 in which the

titanium oxide particle layer was made to form like an example 1, it impressed 20V by having used the carbon plate as the anode, having used copper foil 1 as the cathode, and on the titanium oxide particle layer, the organic macromolecule 7 was deposited, after predrying, it was made to harden at 150 degrees C for 20 minutes, and the organic inorganic compound dielectric layer 2 was formed.
[0046] As an example 1 of a comparison, since a titanium oxide particle is made to electrodeposit in formation of the dielectric of a capacitor and this was dried, according to the example 1, the circuit board with a built-in capacitor was produced except having deposited the organic giant molecule and having formed the organic inorganic complex-dielectrics layer.
[0047] As an example 2 of a comparison, after making a titanium oxide particle layer form in formation of the dielectric of a capacitor, according to the example 1, the circuit board with a built-in capacitor was produced except having not stepped on the process of making an organic giant molecule form, but having made organic giant-molecule electrodeposition liquid suspend a titanium oxide particle, and having carried out the organic inorganic complex-dielectrics stratification at once.
[0048] The result of having investigated each capacitor property (the electrostatic-capacity C:unit nF, loss-value tandelta: unit %) built in the circuit board with a built-in capacitor produced as mentioned above in examples 1-3 and the examples 1 and 2 of a comparison is shown in Table 1. This is the result of measuring by 1kHz of test frequencies using an LCR meter (for example, HP4274A). In addition, in each example and each example of a comparison, the three circuit boards with a built-in capacitor are produced, respectively, and the average of three capacitors built in each is shown in Table 1.
[0049]
[Table 1]

	C／nF（1 kHz）	tan δ／%（1 kHz）
実施例 1	5.63	3.56
実施例 2	12.9	3.88
実施例 3	5.51	3.05
比較例 1	0.01	33.4
比較例 2	1.18	23.1

対極の面積： 1 cm × 1 cm = 1 cm^2

[0050] The capacity (C) of the capacitor of the example 1 of a comparison and the example 2 of a comparison was small, tandelta showing a loss value was large and its capacitor property was bad so that clearly from this table 1. Before pressurization and hot press, since the value of tandelta was 3 - 4% (1kHz), it is considered that the capacitor property got worse by pressurization and hot press. On the other hand, as for the property, pressurization and hot press did not get worse, either, but, as for the capacitor by this examples 1-3, the result very strong against mechanical stress was obtained.
[0051] As mentioned above, according to the gestalt and example of this operation, the metallic-oxide particle 6 of the organic inorganic complex-dielectrics layer 2 of a capacitor so that it may become small as it is large and separates from the front face of the electrode on the front face of the electrode with which the consistency consists of copper foil 1 By making it exist in a consistency with an inclination in the organic inorganic complex-dielectrics layer 2, strongly, it can consider as a dielectric with a high dielectric constant, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in in mechanical stress.
[0052] Moreover, it is desirable from the flexibility (flexibility) of a dielectric, and the point of a dielectric constant that the particle size of the metallic-oxide particle 6 is 0.05-3 micrometers. Since the metallic-oxide particle 6 becomes dense too much and the organic macromolecule 7 cannot enter in a metallic-oxide particle layer well if the particle size of the metallic-oxide particle 6 is smaller than 0.05 micrometers, the flexibility of a dielectric is lost. Conversely, since a clearance will increase in a metallic-oxide particle layer if the particle size of the metallic-oxide particle 6 is larger than 3 micrometers, a dielectric constant does not become large.
[0053] Moreover, a mass capacitor can be built in when the principal components of the metallic-oxide particle 6 are ferroelectrics, such as titanium oxide and barium titanate, like examples 1-3.
[0054] Moreover, by being the particle to which coating of the front face of a metallic oxide was carried out to the metallic-oxide particle 6 with 1 - 10% of the weight of the aluminum oxide, the metallic-oxide particle 6 is homogeneous and can produce a metallic-oxide particle layer with a high dielectric constant. Since the dielectric constant of an aluminum oxide is small compared with the metallic oxide which consists of ferroelectrics, such as titanium oxide, although dispersibility becomes good when the front face of a metallic oxide is coated with the high aluminum oxide of a hydrophilic property, as the coating thickness of an aluminum oxide becomes thick, the dielectric constant of a metallic-oxide particle becomes smaller. Therefore, the thinner possible one of coating is good and its 1 - 10 % of the weight is good to the metallic-oxide particle 6.
[0055] Moreover, since the organic giant molecule 7 is polycarboxylic acid system resin, polyamine system resin, or polyimide system resin, it can consider as a flexible high capacitor. Although the cation system resin of UV hardening mold or a heat-curing mold was used as an organic giant molecule 7 in the example, these are the examples which used polyamine system resin.
[0056] Moreover, by being immersed in the suspension of a metallic-oxide particle, forming a metallic-oxide particle layer in the copper foil 1 of an electrode section according to electrodeposition like the manufacture approach of

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the above-mentioned example, and forming the organic macromolecule 7 according to electrodeposition after that The organic inorganic complex-dielectrics layer 2 which became small as it was large and separated from the electrode surface in the electrode surface in which the consistency of the metallic-oxide particle 6 forms it can be formed. By this Strongly, it can consider as a dielectric with a high dielectric constant, the manufacture process of a printed-circuit multilayer substrate can be suited, and a capacitor with a large capacity can be built in in mechanical stress.

[0057] Moreover, the suspension of a metallic-oxide particle with sufficient dispersibility can be adjusted by containing in the suspension of a metallic-oxide particle the polyamine derivative which has the double bond of carbon and oxygen as a binder five to 20% of the weight to the metallic-oxide particle 6. Although dispersibility of the metallic-oxide particle 6 can be improved by adding the binder of the polyamine system which has the double bond of carbon and oxygen to the suspension of a metallic-oxide particle, since a binder is preferentially electrodeposited when [than 20 % of the weight] more [it is almost ineffective to the metallic-oxide particle 6 if fewer than 5 % of the weight, and], as binder concentration, 5 - 20 % of the weight is good to the metallic-oxide particle 6.

[0058] Moreover, although the suspension of a metallic-oxide particle makes deionized water distribute a metallic-oxide particle, in this suspension, the metallic-oxide particle 6 can form a metallic-oxide particle layer thinly to deionized water by being 1 - 20 % of the weight in a weight ratio. When metallic-oxide particle concentration is 1 or less % of the weight, a metallic-oxide particle layer will not be able to be formed according to electrodeposition, but the metallic-oxide particle 6 will precipitate with time amount at 20 % of the weight or more, without distributing well.

[0059] Moreover, without drying this metallic-oxide particle layer, by forming the organic macromolecule 7, the crack of a metallic-oxide particle layer is prevented, and the leakage current is small and can produce a capacitor with a big capacity after forming a metallic-oxide particle layer.

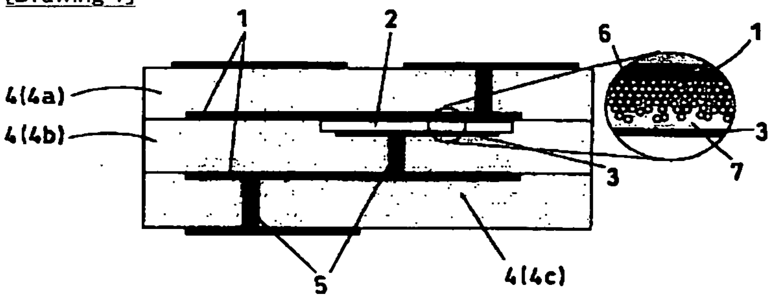
[0060] moreover, the metallic-oxide particle layer which consists of a metallic-oxide particle 6 with a high dielectric constant by changing electrodeposted time amount and electrodeposted potential and the organic giant molecule 7 — since each thickness can be adjusted, a dielectric constant and the capacitor which controlled pressure-proofing can be obtained easily.

[0061] Moreover, as a counter electrode 3, vacuum evaporationo of metal plating, such as nickel besides copper plating and a conductive polymer, aluminum, zinc, etc. is sufficient.

[Translation done.]

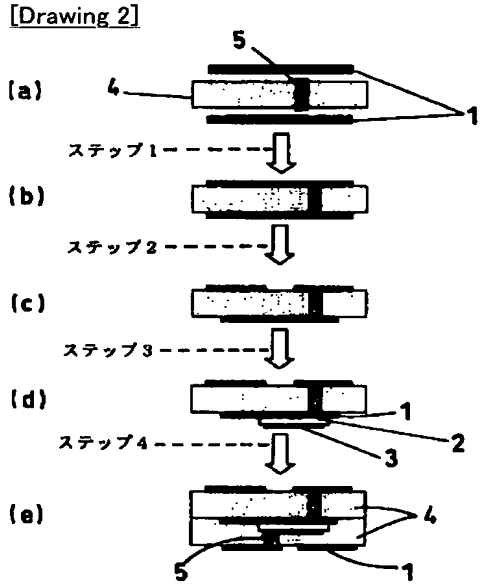
DRAWINGS

[Drawing 1]



1 銅箔
2 有機無機複合誘電体層
3 対極
4 絶縁基板
5 インナービアホール
6 金属酸化物微粒子
7 有機高分子

[Drawing 2]



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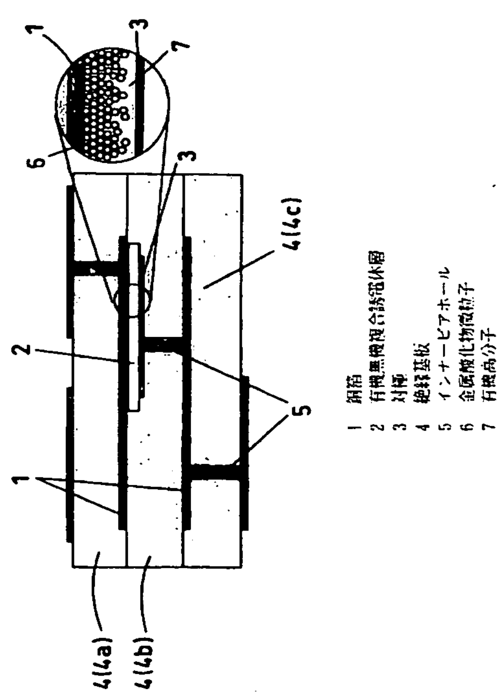
(71)出願人　000005821
松下電器産業株式会社
大阪府門真市大字門真1006番地
(72)発明者　竹岡　宏樹
大阪府門真市大字門真1006番地　松下電器産業株式会社内
(72)発明者　斎藤　俊晴
大阪府門真市大字門真1006番地　松下電器産業株式会社内
(74)代理人　100076174
弁理士　宮井　暎夫

最終頁に続く

(54)【発明の名称】　コンデンサ内蔵回路基板およびその製造方法

(57)【要約】
【課題】　プリント配線多層基板の製造プロセスに適合し、高容量のコンデンサを内蔵したコンデンサ内蔵回路基板を実現する。
【解決手段】　プリプレグの絶縁基板４ａの銅箔１の表面に、電着により誘電率の高い酸化チタン等の金属酸化物微粒子６を形成しさらに電着により有機高分子７を形成することで有機無機複合誘電体層２を形成し、この誘電体層２の表面に銅めっきにより対極３を形成してコンデンサを完成させ、このコンデンサを挟むように別の絶縁基板４ｂ，４ｃを接着する。有機無機複合誘電体層２は、金属酸化物微粒子６の密度が銅箔１表面で大きく、その銅箔１表面から離れるに従い小さくなり、これにより、機械的ストレスに強く、且つ誘電率の高い誘電体とすることができ、プリント配線多層基板の製造プロセスに適合し、容量の大きいコンデンサとすることができる。



【特許請求の範囲】

【請求項１】　表面にコンデンサの第１の電極を含む金属箔の回路パターンを有する回路基板と、前記第１の電極の表面に形成した前記コンデンサの誘電体と、前記誘電体の表面に形成した前記コンデンサの第２の電極とを備え、

前記誘電体は、金属酸化物微粒子および有機高分子を含む有機無機複合誘電体層からなり、前記金属酸化物微粒子はその密度が前記第１の電極の表面で大きく、前記第１の電極の表面から離れるに従い小さくなるように、前記有機無機複合誘電体層中で密度に傾斜をもって存在することを特徴とするコンデンサ内蔵回路基板。

【請求項２】　金属酸化物微粒子の粒径が０．０５～３μｍであることを特徴とする請求項１記載のコンデンサ内蔵回路基板。

【請求項３】　金属酸化物微粒子の主成分が酸化チタン、チタン酸バリウム等の強誘電体であることを特徴とする請求項１または２記載のコンデンサ内蔵回路基板。

【請求項４】　金属酸化物微粒子は金属酸化物の表面を酸化アルミニウムでコーティングした微粒子であり、コーティングする前記酸化アルミニウムは前記金属酸化物微粒子に対して１～１０重量％であることを特徴とする請求項１，２または３記載のコンデンサ内蔵回路基板。

【請求項５】　有機高分子がポリカルボン酸系樹脂、ポリアミン系樹脂、ポリイミド系樹脂のうちのいずれかであることを特徴とする請求項１，２，３または４記載のコンデンサ内蔵回路基板。

【請求項６】　表面に前記コンデンサを設けた前記回路基板と他の回路基板とを前記コンデンサを介して接着したことを特徴とする請求項１，２，３，４または５記載のコンデンサ内蔵回路基板。

【請求項７】　表面にコンデンサの電極を含む金属箔の回路パターンを有する回路基板を金属酸化物微粒子の懸濁液に浸漬し、電着により前記電極の所定の位置に金属酸化物微粒子層を形成する工程と、この金属酸化物微粒子層の表面に電着により有機高分子を形成する工程とを有するコンデンサ内蔵回路基板の製造方法。

【請求項８】　金属酸化物微粒子の懸濁液にバインダーとして炭素と酸素の二重結合を有するポリアミン誘導体が金属酸化物微粒子に対して５～２０重量％含まれることを特徴とする請求項７記載のコンデンサ内蔵回路基板の製造方法。

【請求項９】　金属酸化物微粒子が脱イオン水に対して重量比で１～２０％であることを特徴とする請求項７または８記載のコンデンサ内蔵回路基板の製造方法。

【請求項１０】　金属酸化物微粒子層を形成後、この金属酸化物微粒子層を乾燥させずに、有機高分子を形成することを特徴とする請求項７，８または９記載のコンデンサ内蔵回路基板の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、電気機器・電子機器・音響機器の電子回路などに用いるコンデンサ内蔵回路基板およびその製造方法に関するものである。

【０００２】

【従来の技術】近年、機器の小型化・薄型化・軽量化、および電気機器回路の高密度化・デジタル化に伴い、電子部品に対する小型化、高性能化高信頼性化の要望がますます高まってきている。そのような情勢の中で、コンデンサも同様の小型で大容量を有するものが要求されている。

【０００３】しかしながら、プリント配線基板上でコンデンサなどの実装部品が占める面積は依然として大きい。このことが、今後電子機器の更なる小型化をしようとする際の大きな障害になる。そのような問題を解決するために、コンデンサなどの電子部品を回路基板に内蔵する試みがなされている（例えば、特開平１０－５６２５１号公報、特開平１１－６８３２１号公報）。

【０００４】一方、ＩＣ回路の高周波化や低電圧化に伴って、ノイズによって電源電圧が変動し、誤動作を生じることが大きな問題となってきている。このような問題が生じる理由は、電源電圧の低電圧化に伴い、電源電圧の許容変動幅が小さくなってきたからである。高周波ノイズによる誤動作を防止するために、通常コンデンサを電源周りに設置している。このような用途に使用されるコンデンサは、バイパスコンデンサやデカップリングコンデンサと呼ばれ、高周波ノイズを除去したり、電源電圧の瞬間的な低下をコンデンサからの瞬時のエネルギー供給により防ぐ働きをしている。このエネルギー供給には、コンデンサの静電容量の大きさが重要な役割を果たす。

【０００５】理想的なコンデンサは抵抗成分やインダクタンス成分が０で静電容量成分のみであるはずであるが、実際のコンデンサは直列抵抗成分と直列インダクタンス成分を持つ。容量成分のインピーダンスは、周波数増加とともに減少し、インダクタンス成分は周波数増加とともに増加する。このため、今後、動作周波数が高くなるにつれ、素子の持つインダクタンス成分や配線によるインダクタンス成分がノイズの原因になると予想される。そのようなことから、コンデンサとしてはできるだけインダクタンス成分が小さいものを使用し、コンデンサ自体の自己共振周波数を高くすることにより、確実に高周波域までコンデンサとして機能させる必要がある。また、デカップリングコンデンサの実装位置は、配線距離によるインダクタンス成分をできるだけ小さくするためにＣＰＵに近接な程良い。

【０００６】一方、設置するコンデンサの使用定格電圧は、前述のような電源電圧の低電圧化に伴い、今後ますます小さいもので対応できるようになる。

【０００７】上記のようなＩＣ回路の高周波化、低電圧

化の課題に対応するために、高性能のコンデンサをプリント配線基板内部に埋設し、ＣＰＵとコンデンサ間の配線距離をできるだけ短くしようとした提案が幾つか開示されている（例えば、特開平４－２１１１９１号公報、特開平１０－３３５１７８号公報、特開平１１－１１１５６１号公報参照）。

【０００８】以上のような電子機器の小型化および回路の高速化を今後飛躍的に伸長させるには、プリント配線基板内に高性能のコンデンサを内蔵することが必須である。またコンデンサを内蔵させることにより実装費を削減できるメリットもある。

【０００９】現在までに、セラミック基板に無機物系の高誘電率誘電体を有するコンデンサを内蔵した提案（例えば、特開平４－２１１１９１号公報、特開平１１－６８３２１号、特開平８－１８１４５３号公報、特開平１０－３３５１７８号公報、特開平１１－１１１５６１号公報参照）や、樹脂基板にコンデンサを内蔵した提案（例えば、特開平８－１２５３０２号公報、特開平８－２４２０５５号公報、特開平１０－５６２５１号公報参照）など、いくつかの提案が開示されている。

【００１０】現在、携帯電話に代表される小型携帯機器内のプリント配線基板材料の主流は樹脂基板である。樹脂基板に、若干の可撓性があり、高周波特性が優れ、なおかつ様々な静電容量を有するコンデンサを内蔵することが熱望されている。

【００１１】これまでに開示された提案の中では、誘電体として高温焼成を必要とするセラミックス系の材料をセラミック基板に埋め込むものが多かった（例えば、特開平８－２２２６５６号公報、特開平８－１８１４５３号公報参照）。しかし、樹脂基板にコンデンサを内蔵する場合、焼成より誘電体となるセラミックス系ペーストを基板内に形成した後に、樹脂基板ごと高温で焼成することは不可能である。そのため、樹脂基板には後付で単品のセラミックコンデンサを埋め込まなければならないという手間が必要であった。また、一般的な高誘電率セラミックス系誘電体は、GHｚ帯で誘電率が大きく低下し、なおかつ温度特性が良くないものも多いため、基板内蔵用途には特性の吟味が必要であった。

【００１２】また、特開平１０－５６２５１号公報には、樹脂基板に貫通孔を設けてそこに誘電体を充填し、コンデンサの機能を付加した基板の構成が開示されている。この方法では、樹脂基板の厚み分全部に誘電体を充填しなければならないので誘電体がどうしても厚くなってしまうことと、孔の面積分しかコンデンサとして機能しないという二つのことから、大きな静電容量を得ることが困難であったと予想される。また、孔の面積を変えたり、充填物の誘電率を変えることによって、様々な静電容量を持つコンデンサを同時に作り込むためには手間のかかる操作を必要とする。

【００１３】現在使用されている樹脂基板の多くは、樹脂基板に銅箔を加圧・加熱プレス接着した後、銅箔をエッチングすることにより配線パターンを形成している。また、銅箔を張った基板を複数枚接着し多層にする場合は、基板に設けたビアホールやスルーホールに充填した導電性物質を介して、基板層間が電気的に接続されている。このような樹脂基板にコンデンサを内蔵する場合、樹脂基板の製造プロセスに適合し易いコンデンサを内蔵し、製造コストを高めない方法が望ましい。

【００１４】

【発明が解決しようとする課題】しかしながら、単品のコンデンサを個別に前記のような樹脂基板に内蔵しようとすると、基板材料にコンデンサを埋め込むための切り抜きスペースを設ける工程が必要となり、コスト高になる。

【００１５】さらに、樹脂基板製造時のプレス時には、大きな機械的ストレスがかかるため、特開平６－１８１３６９号公報に記載されているような誘電体として酸化アルミニウムや五酸化タンタルのような無機酸化物薄膜を使用することは、誘電体が脆くて破壊される可能性があり、製造プロセス上適していない。

【００１６】また、特開平８－１２５３０２号公報、特開平８－２４２０５５号公報に記載のように、基板に接着された銅箔に誘電体ペーストを塗布してコンデンサを形成する方法は、誘電体の膜厚の制御が難しく、静電容量を大きくしたり、容量精度を出すことが困難であったと予想される。

【００１７】本発明の目的は、上記従来の問題点を解決するもので、プリント配線多層基板の製造プロセスに適合し、高容量のコンデンサを内蔵したコンデンサ内蔵回路基板およびその製造方法を提供することである。

【００１８】

【課題を解決するための手段】上記目的を達成するために本発明のコンデンサ内蔵回路基板は、表面にコンデンサの第１の電極を含む金属箔の回路パターンを有する回路基板と、第１の電極の表面に形成したコンデンサの誘電体と、誘電体の表面に形成したコンデンサの第２の電極とを備え、誘電体は、金属酸化物微粒子および有機高分子を含む有機無機複合誘電体層からなり、金属酸化物微粒子はその密度が第１の電極の表面で大きく、第１の電極の表面から離れるに従い小さくなるように、有機無機複合誘電体層中で密度に傾斜をもって存在することを特徴とする。この構成により、機械的ストレスに強く、且つ誘電率の高い誘電体とすることができ、プリント配線多層基板の製造プロセスに適合し、容量の大きいコンデンサを内蔵することができる。

【００１９】なお、有機無機複合誘電体層中の金属酸化物微粒子の密度はコンデンサの第１の電極からの距離に比例して直線的に小さくなる場合に限られるものではない。

【００２０】また、金属酸化物微粒子の粒径が０．０５

～３μｍであることが、誘電体の柔軟性（可撓性）および誘電率の点から好ましい。金属酸化物微粒子の粒径が０．０５μｍよりも小さいと金属酸化物微粒子が密になりすぎて、有機高分子がうまく金属酸化物微粒子層内に入り込めないため誘電体の可撓性が失われる。逆に金属酸化物微粒子の粒径が３μｍよりも大きいと金属酸化物微粒子層に隙間が多くなるため誘電率が大きくならない。

【００２１】また、金属酸化物微粒子の主成分が酸化チタン、チタン酸バリウム等の強誘電体であることにより、大容量のコンデンサを内蔵できる。

【００２２】また、金属酸化物微粒子は、金属酸化物の表面が金属酸化物微粒子に対して１～１０重量％の酸化アルミニウムでコーティングされた微粒子であることにより、均質で誘電率の高い金属酸化物微粒子層を作製できる。金属酸化物の表面を親水性の高い酸化アルミニウムでコーティングすると分散性が良くなるが、酸化アルミニウムの誘電率は酸化チタン等の強誘電体からなる金属酸化物に比べて小さいので、酸化アルミニウムのコーティング厚さが厚くなればなるほど金属酸化物微粒子の誘電率が小さくなる。そのためコーティングはできるだけ薄い方がよく、金属酸化物微粒子に対して１～１０重量％がよい。

【００２３】また、有機高分子がポリカルボン酸系樹脂、ポリアミン系樹脂、ポリイミド系樹脂のいずれかであることから、可撓性の高いコンデンサとすることができる。

【００２４】また、上述の表面にコンデンサを設けた回路基板と他の回路基板とをコンデンサを介して接着しても、前述のように機械的ストレスに強いため、コンデンサ特性が悪化しない。

【００２５】また、本発明のコンデンサ内蔵回路基板の製造方法は、表面にコンデンサの電極を含む金属箔の回路パターンを有する回路基板を金属酸化物微粒子の懸濁液に浸漬し、電着により電極の所定の位置に金属酸化物微粒子層を形成する工程と、この金属酸化物微粒子層の表面に電着により有機高分子を形成する工程とを有する。この製造方法により、金属酸化物微粒子の密度がそれを形成する電極表面で大きく、その電極表面から離れるに従い小さくなった有機無機複合誘電体層を形成することができ、これにより、機械的ストレスに強く、且つ誘電率の高い誘電体とすることができ、プリント配線多層基板の製造プロセスに適合し、容量の大きいコンデンサを内蔵することができる。

【００２６】また、金属酸化物微粒子の懸濁液にバインダーとして炭素と酸素の二重結合を有するポリアミン誘導体が金属酸化物微粒子に対して５～２０重量％含まれることにより、分散性の良い金属酸化物微粒子の懸濁液を調整できる。金属酸化物微粒子の懸濁液に炭素と酸素の二重結合を有するポリアミン系のバインダーを加えることによって金属酸化物微粒子の分散性を良くすることができるが、金属酸化物微粒子に対して５重量％よりも少ないと効果はほとんどなく、２０重量％よりも多いとバインダーが優先的に電着されるため、バインダー濃度としては金属酸化物微粒子に対して５～２０重量％がよい。

【００２７】また、金属酸化物微粒子の懸濁液において金属酸化物微粒子が脱イオン水に対して重量比で１～２０重量％であることにより、金属酸化物微粒子層を薄く形成することができる。金属酸化物微粒子濃度が１重量％以下の場合、電着により金属酸化物微粒子層を形成できず、２０重量％以上ではうまく分散せずに時間とともに金属酸化物微粒子が沈殿してしまう。

【００２８】また、金属酸化物微粒子層を形成後、この金属酸化物微粒子層を乾燥させずに、有機高分子を形成することにより、金属酸化物微粒子層のクラックを防ぎ、漏れ電流が小さく、容量の大きなコンデンサを内蔵した回路基板を作製できる。

【００２９】

【発明の実施の形態】以下、本発明の実施の形態について図面を参照しながら説明する。

【００３０】図１は本発明の実施の形態のコンデンサ内蔵回路基板の断面図である。図１において、１は銅箔、２は電着により形成された有機無機複合誘電体層、３は例えば銅めっきで形成された対極、４はプリプレグの絶縁基板、５はインナービアホール、６は金属酸化物微粒子、７は有機高分子である。

【００３１】本実施の形態のコンデンサ内蔵回路基板は、銅箔１で回路パターンが形成された複数枚のプリプレグの絶縁基板４を接着したものであり、図１では３枚の絶縁基板４（４ａ，４ｂ，４ｃ）を例に示している。絶縁基板４ａに接着された銅箔１の一部がコンデンサの一方の電極となり、その電極部分と有機無機複合誘電体層２と対極３とからなるコンデンサが、絶縁基板４ａに設けられ、そのコンデンサを挟むように絶縁基板４ｂが接着されている。

【００３２】このコンデンサの誘電体である有機無機複合誘電体層２は、金属酸化物微粒子６および有機高分子７からなり、有機無機複合誘電体層２中の金属酸化物微粒子６はその密度が銅箔１表面で大きく、銅箔１表面から離れるに従い小さくなるように、有機無機複合誘電体層２中で銅箔１付近から対極３方向へ密から粗へ密度の傾斜をもって存在している。金属酸化物微粒子６は、酸化チタンやチタン酸バリウム等の強誘電体である金属酸化物の表面を酸化アルミニウムでコーティングした微粒子である。

【００３３】なお、図１のように、３枚の絶縁基板４（４ａ，４ｂ，４ｃ）を用いる場合、絶縁基板を１枚ずつ順次接着してもよいし、３枚同時に重ねて接着するようにしてもよい。

【００３４】また、コンデンサの一方の電極を含む回路パターンに銅箔１を用いているが、Ａｌ箔など他の金属箔や導電体を用いることができる。

【００３５】

【実施例】図１のようなコンデンサ内蔵回路基板について、以下の各実施例で、その具体的な構成例とその製造方法を説明する。なお、以下の各実施例では、２枚のプリプレグの絶縁基板が接着されたコンデンサ内臓回路基板について説明する。

【００３６】（実施例１）この実施例１では、図１のコンデンサにおいて、金属酸化物微粒子６として、表面を酸化アルミニウムでコーティングした酸化チタン微粒子を用い、有機高分子７として、ＵＶ硬化型カチオン系樹脂を用いた構成である。

【００３７】この場合の製造方法を図２の工程順断面図を用いて詳細に説明する。

【００３８】まず、ステップ１で、アラミド繊維にエポキシ系樹脂を含浸したプリプレグの絶縁基板４に粗面化した銅箔１を加熱・加圧プレスによって接着した（図２（ａ），（ｂ））。このプリプレグの絶縁基板４にはあらかじめ銅ペーストが充填されたインナービアホール５が形成されたものを用いた。

【００３９】次に、ステップ２で、塩化第二鉄溶液によって銅箔１の不要部分をエッチングし、コンデンサの一方の電極を含む回路パターンを形成した（図２（ｃ））。

【００４０】次に、ステップ３で、表面を酸化アルミで親水化処理した酸化チタン微粒子（平均粒径０．１μｍ）を２．５重量％含む酸化チタン懸濁水溶液（ポリアミン系バインダーを０．２５重量％含有）に銅箔１を浸漬し、その銅箔１をカソード、炭素板をアノードとして１０Ｖ印加することによりコンデンサの電極部分の銅箔１上に酸化チタン微粒子を析出させた。次にこの酸化チタン微粒子層を乾燥させずにそのままＵＶ硬化型カチオン系樹脂塗料中に浸漬し、銅箔１をカソード、炭素板をアノードとして１５Ｖ印加し、酸化チタン微粒子層（６）上に有機高分子７を析出させ、予備乾燥の後、ＵＶ照射により硬化させて有機無機複合誘電体層２を形成した。この複合誘電体層２上に無電解銅めっき、続いて電気銅めっきを行うことにより対極３を形成し、薄型のコンデンサを作製した（図２（ｄ））。

【００４１】なお、酸化チタン微粒子（６）および有機高分子７を析出させる際、図２の（ｄ）の有機無機複合誘電体層２で示されるように、所定の銅箔１のある部分にのみ析出させるが、これは、電着したくない部分にはマスクをして行う。マスキング剤としては、レジスト、マスキングシール等を用いる。

【００４２】次に、ステップ４で、薄型のコンデンサが作製された絶縁基板４を、あらかじめ片側に銅箔１が接着してあるプリプレグの絶縁基板４と加熱・加圧プレスにより接着してコンデンサ内蔵回路基板を作製した（図２（ｅ））。なお、接着する際の条件は、真空雰囲気下で圧力５０×９．８Ｎ／ｃｍ^2（５０ｋｇｆ／ｃｍ^2）、温度２００℃、保持時間６０分とした。なお、接着の際には、薄型コンデンサと図２（ｅ）における下側の絶縁基板４のインナービアホール５内の銅ペーストとの導通が充分とれるように位置合わせをしてプレスした。なお、図２（ｅ）の上下の絶縁基板４を接着する前の下側の絶縁基板４の表面は平坦であり、下側のプリプレグの絶縁基板４の表面に、上側のコンデンサがめり込んだようになる。

（実施例２）この実施例２では、図１のコンデンサにおいて、金属酸化物微粒子４として、表面を酸化アルミニウムでコーティングしたチタン酸バリウム微粒子を用い、有機高分子７として、実施例１同様、ＵＶ硬化型カチオン系樹脂を用いた構成である。

【００４３】この場合の製造方法は、実施例１における表面を酸化アルミニウムでコーティングし親水化処理した酸化チタン微粒子のかわりに、表面を酸化アルミニウムでコーティングし親水化処理したチタン酸バリウム微粒子を用いた以外は実施例１に準じてコンデンサ内蔵回路基板を作製した。

【００４４】（実施例３）この実施例３では、有機高分子７として、熱硬化型カチオン系樹脂を用いた以外は実施例１と同じ構成である。

【００４５】この場合の製造方法は、有機高分子７を形成する電着樹脂溶液に、実施例１におけるＵＶ硬化型カチオン系樹脂の代わりに熱硬化型カチオン系樹脂を用いた以外は実施例１に準じてコンデンサ内蔵回路基板を作製した。この場合、実施例１と同様に酸化チタン微粒子層を形成させた銅箔１を乾燥させずにそのまま熱硬化型カチオン系樹脂塗料中に浸漬し、銅箔１をカソード、炭素板をアノードとして２０Ｖ印加し、酸化チタン微粒子層上に有機高分子７を析出させ、予備乾燥の後、１５０℃で２０分硬化させて有機無機複合誘電層２を形成した。

【００４６】比較例１として、コンデンサの誘電体の形成において、酸化チタン微粒子を電着させ、これを乾燥させてから有機高分子を析出させて有機無機複合誘電体層を形成した以外は実施例１に準じてコンデンサ内蔵回路基板を作製した。

【００４７】比較例２として、コンデンサの誘電体の形成において、酸化チタン微粒子層を形成させた後、有機高分子を形成させるといった工程を踏まず、酸化チタン微粒子を有機高分子電着液に懸濁させて一度に有機無機複合誘電体層形成した以外は実施例１に準じてコンデンサ内蔵回路基板を作製した。

【００４８】以上のように実施例１～３および比較例１，２で作製したコンデンサ内蔵回路基板に内蔵されたそれぞれのコンデンサ特性（静電容量Ｃ：単位ｎＦ、損

失値tanδ：単位%）を調べた結果を表１に示す。これはＬＣＲメータ（例えばＨＰ４２７４Ａ）を用い測定周波数１ｋＨｚで測定した結果である。なお、各実施例および各比較例ではそれぞれ３個のコンデンサ内蔵回路基板を作製し、表１にはそれぞれに内蔵された３個のコンデンサの平均値を示している。

【００４９】

【表１】

	C／nF（1 kHz）	tanδ／%（1 kHz）
実施例１	5.63	3.56
実施例２	12.9	3.88
実施例３	5.51	3.05
比較例１	0.01	33.4
比較例２	1.18	23.1

対極の面積：1 cm×1 cm＝1 cm^2

【００５０】この表１から明らかなように、比較例１および比較例２のコンデンサは、容量（Ｃ）は小さく、損失値を表わすtanδは大きく、コンデンサ特性が悪かった。加圧・加熱プレス前ではtanδの値は３～４％（１ｋＨｚ）であったことから加圧・加熱プレスでコンデンサ特性が悪化したと考えられる。これに対し、本実施例１～３によるコンデンサは加圧・加熱プレスでも特性は悪化せず、非常に機械的ストレスに強い結果が得られた。

【００５１】以上のように本実施の形態および実施例によれば、コンデンサの有機無機複合誘電体層２の金属酸化物微粒子６をその密度が銅箔１からなる電極の表面で大きく、その電極の表面から離れるに従い小さくなるように、有機無機複合誘電体層２中で密度に傾斜をもって存在させることにより、機械的ストレスに強く、且つ誘電率の高い誘電体とすることができ、プリント配線多層基板の製造プロセスに適合し、容量の大きいコンデンサを内蔵することができる。

【００５２】また、金属酸化物微粒子６の粒径が０．０５～３μｍであることが、誘電体の柔軟性（可撓性）および誘電率の点から好ましい。金属酸化物微粒子６の粒径が０．０５μｍよりも小さいと金属酸化物微粒子６が密になりすぎて、有機高分子７がうまく金属酸化物微粒子層内に入り込めないため誘電体の可撓性が失われる。逆に金属酸化物微粒子６の粒径が３μｍよりも大きいと金属酸化物微粒子層に隙間が多くなるため誘電率が大きくならない。

【００５３】また、金属酸化物微粒子６の主成分が実施例１～３のように酸化チタン、チタン酸バリウム等の強誘電体であることにより、大容量のコンデンサを内蔵できる。

【００５４】また、金属酸化物微粒子６は、金属酸化物の表面が金属酸化物微粒子６に対して１～１０重量%の酸化アルミニウムでコーティングされた微粒子であることにより、均質で誘電率の高い金属酸化物微粒子層を作製できる。金属酸化物の表面を親水性の高い酸化アルミニウムでコーティングすると分散性が良くなるが、酸化アルミニウムの誘電率は酸化チタン等の強誘電体からなる金属酸化物に比べて小さいので、酸化アルミニウムのコーティング厚さが厚くなればなるほど金属酸化物微粒子の誘電率が小さくなる。そのためコーティングはできるだけ薄い方がよく、金属酸化物微粒子６に対して１～１０重量%がよい。

【００５５】また、有機高分子７がポリカルボン酸系樹脂、ポリアミン系樹脂、ポリイミド系樹脂のいずれかであることから、可撓性の高いコンデンサとすることができる。実施例では、有機高分子７として、ＵＶ硬化型あるいは熱硬化型のカチオン系樹脂を用いたが、これらはポリアミン系樹脂を用いた例である。

【００５６】また、上記実施例の製造方法のように、金属酸化物微粒子の懸濁液に浸漬し、電着により電極部分の銅箔１に金属酸化物微粒子層を形成し、その後に電着により有機高分子７を形成することにより、金属酸化物微粒子６の密度がそれを形成する電極表面で大きく、その電極表面から離れるに従い小さくなった有機無機複合誘電体層２を形成することができ、これにより、機械的ストレスに強く、且つ誘電率の高い誘電体とすることができ、プリント配線多層基板の製造プロセスに適合し、容量の大きいコンデンサを内蔵することができる。

【００５７】また、金属酸化物微粒子の懸濁液にバインダーとして炭素と酸素の二重結合を有するポリアミン誘導体が金属酸化物微粒子６に対して５～２０重量%含まれることにより、分散性の良い金属酸化物微粒子の懸濁液を調整できる。金属酸化物微粒子の懸濁液に炭素と酸素の二重結合を有するポリアミン系のバインダーを加えることによって金属酸化物微粒子６の分散性を良くすることができるが、金属酸化物微粒子６に対して５重量%よりも少ないと効果はほとんどなく、２０重量%よりも多いとバインダーが優先的に電着されるため、バインダー濃度としては金属酸化物微粒子６に対して５～２０重量%がよい。

【００５８】また、金属酸化物微粒子の懸濁液は脱イオン水に金属酸化物微粒子を分散させたものであるが、この懸濁液において金属酸化物微粒子６が脱イオン水に対して重量比で１～２０重量%であることにより、金属酸化物微粒子層を薄く形成することができる。金属酸化物微粒子濃度が１重量%以下の場合、電着により金属酸化物微粒子層を形成できず、２０重量%以上ではうまく分

散せずに時間とともに金属酸化物微粒子６が沈殿してしまう。

【００５９】また、金属酸化物微粒子層を形成後、この金属酸化物微粒子層を乾燥させずに、有機高分子７を形成することにより、金属酸化物微粒子層のクラックを防ぎ、漏れ電流が小さく、容量の大きなコンデンサを作製できる。

【００６０】また、電着時間、電着電位を変えることで誘電率の高い金属酸化物微粒子６からなる金属酸化物微粒子層と有機高分子７それぞれの厚さを調節できることから誘電率、耐圧をコントロールしたコンデンサを容易に得ることができる。

【００６１】また、対極３としては銅めっき、導電性高分子の他、ニッケルなどの金属めっき、アルミニウムや亜鉛などの蒸着でも良い。

【００６２】

【発明の効果】本発明のコンデンサ内蔵回路基板は、表面にコンデンサの第１の電極を含む金属箔の回路パターンを有する回路基板と、第１の電極の表面に形成したコンデンサの誘電体と、誘電体の表面に形成したコンデンサの第２の電極とを備え、誘電体は、金属酸化物微粒子および有機高分子を含む有機無機複合誘電体層からなり、金属酸化物微粒子はその密度が第１の電極の表面で大きく、第１の電極の表面から離れるに従い小さくなるように、有機無機複合誘電体層中で密度に傾斜をもって存在するものであり、この構成により、機械的ストレスに強く、且つ誘電率の高い誘電体とすることができ、プリント配線多層基板の製造プロセスに適合し、容量の大きいコンデンサを内蔵することができる。

【００６３】また、金属酸化物微粒子の粒径が０．０５～３μｍであることが、誘電体の柔軟性（可撓性）に優れ、誘電率を高くする上で好ましい。

【００６４】また、金属酸化物微粒子の主成分が酸化チタン、チタン酸バリウム等の強誘電体であることにより、大容量のコンデンサを内蔵できる。

【００６５】また、金属酸化物微粒子は、金属酸化物の表面が金属酸化物微粒子に対して１～１０重量％の酸化アルミニウムでコーティングされた微粒子であることにより、均質で誘電率の高い金属酸化物微粒子層を作製できる。

【００６６】また、有機高分子がポリカルボン酸系樹脂、ポリアミン系樹脂、ポリイミド系樹脂のいずれかであることから、可撓性の高いコンデンサとすることができる。

【００６７】また、上述の表面にコンデンサを設けた回路基板と他の回路基板とをコンデンサを介して接着しても、前述のように機械的ストレスに強いため、コンデンサ特性が悪化しない。

【００６８】また、本発明のコンデンサ内蔵回路基板の製造方法は、表面にコンデンサの電極を含む金属箔の回路パターンを有する回路基板を金属酸化物微粒子の懸濁液に浸漬し、電着により電極の所定の位置に金属酸化物微粒子層を形成する工程と、この金属酸化物微粒子層の表面に電着により有機高分子を形成する工程とを有することにより、金属酸化物微粒子の密度がそれを形成する電極表面で大きく、その電極表面から離れるに従い小さくなった有機無機複合誘電体層を形成することができ、これにより、機械的ストレスに強く、且つ誘電率の高い誘電体とすることができ、プリント配線多層基板の製造プロセスに適合し、容量の大きいコンデンサを内蔵することができる。

【００６９】また、金属酸化物微粒子の懸濁液にバインダーとして炭素と酸素の二重結合を有するポリアミン誘導体が金属酸化物微粒子に対して５～２０重量％含まれることにより、分散性の良い金属酸化物微粒子の懸濁液を調整できる。

【００７０】また、金属酸化物微粒子の懸濁液において金属酸化物微粒子が脱イオン水に対して重量比で１～２０重量％であることにより、金属酸化物微粒子層を薄く形成することができる。

【００７１】また、金属酸化物微粒子層を形成後、この金属酸化物微粒子層を乾燥させずに、有機高分子を形成することにより、金属酸化物微粒子層のクラックを防ぎ、漏れ電流が小さく、容量の大きなコンデンサを内蔵した回路基板を作製できる。

【００７２】以上のように、プリント配線多層基板の製造プロセスに適合し、高周波用途に適し、小型化が図れるとともに生産性の高いコンデンサ内蔵回路基板を実現することができ、電子機器の一層の小型化に貢献することができる。

【図面の簡単な説明】

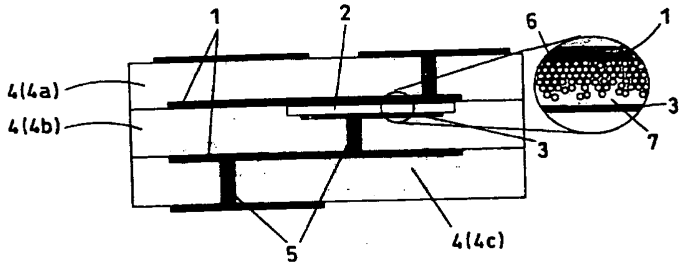
【図１】本発明の実施の形態のコンデンサ内蔵回路基板の断面の模式図

【図２】本発明の実施例におけるコンデンサ内蔵回路基板の製造工程を示す断面図

【符号の説明】

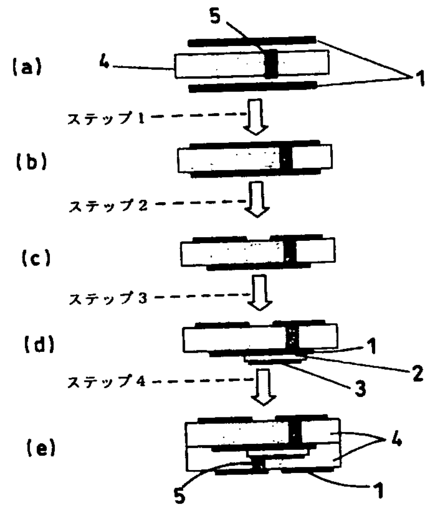
１　銅箔
２　有機無機複合誘電体層
３　対極
４　絶縁基板
５　インナービアホール
６　金属酸化物微粒子
７　有機高分子

【図１】



1　銅箔
2　有機無機複合誘電体層
3　対極
4　絶縁基板
5　インナービアホール
6　金属酸化物微粒子
7　有機高分子

【図２】



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(72)発明者　塩田　浩平
大阪府門真市大字門真1006番地　松下電器産業株式会社内

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